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तापीय लिंक — अपेक्षा और अनुप्रयोग मार्गदर्शिका

Indian Standard

THERMAL LINKS — REQUIREMENTS AND APPLICATION GUIDE

ICS 29.120.50

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

August 1996 **Price Group 9**

Fuses Sectional Committee, ET 39

NATIONAL FOREWORD

This Indian Standard which is identical to IEC Pub 691 (1993), issued by the International, Electrotechnical Commission, was adopted by the Bureau of Indian Standards along with Amendment No. 1 to the IEC Publication on the recommendations of the Fuses Sectional Committee (ET 39) and approval of the Electrotechnical Division Council.

The text of the IEC standard and its amendment has been approved as suitable for publication as Indian Standard without deviations.

Thermal links, defined as non-resettable devices, functioning once only without refunctioning, are widely applied for the thermal protection of equipment in which, under fault conditions, one or more parts may reach hazardous temperatures.

In the adopted standard, certain terminology and conventions are not identical with those used in Indian Standards. Attention is specially drawn to the following :

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.
b) Comma (,) has been used as a decimal marker while in Indian standard, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 65 (1985)	IS 616 :1986	Identical
IEC 68-2-(Sec 1 to Sec 68)	IS 9000 (Part 2 to Part 31)	Technically equivalent
IEC 112 (1979)	IS 2824 : 1975	Technically equivalent
IEC 260 (1968)	Nil	—

Amendment No. 1 issued to IEC 691 (1993) is to be read along with this standard and is given at the end.

Only the English language text in the International Standards has been retained while adopting it in this Indian Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

BIS Certification Marking

The product may also be marked with Standard Mark.

The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standard Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

Indian Standard

THERMAL LINKS — REQUIREMENTS AND APPLICATION GUIDE

1 Scope and object

1.1 This International Standard is applicable to thermal-links, intended for incorporation in electrical appliances, electronic equipment and component parts thereof, normally intended for use indoors, in order to protect them against excessive temperatures under abnormal conditions.

NOTES

1 The equipment need not be designed to generate heat

2 The effectiveness of the protection against excessive temperatures logically depends upon the position and method of mounting of the thermal link, as well as upon the current which it is carrying

3 Attention is drawn to the fact that the external creepage distances and clearances specified in table 3 may in some cases be smaller than those required by certain appliance or equipment standards In such cases, additional means should be provided when a thermal-link is mounted in the equipment in order to adjust the creepage distances and clearances to the values required by the relevant equipment standard

1.2 This standard may be applicable to thermal-links for use under other than indoor conditions, provided that the climatic and other circumstances in the immediate surroundings of such thermal-links are comparable with those in this standard

1.3 This standard may be applicable to thermal-links in their simplest forms (e.g. melting strips or wires), provided that molten materials, expelled during function, cannot adversely interfere with the safe use of the equipment, especially in the case of hand-held or portable equipment irrespective of its attitude

1.4 This standard is applicable to thermal-links with a rated voltage not exceeding 660 V a.c. and a rated current not exceeding 63 A.

1.5 This standard is not applicable to thermal-links used under extreme conditions such as corrosive or explosive atmospheres.

1.6 This standard is applicable to thermal-links primarily intended for use in circuits operating on a.c. with a frequency between 45 Hz and 62 Hz.

1.7 The object of this standard is:

a) to establish uniform requirements for thermal-links;

b) to define methods of test;

c) to provide useful information for the application of thermal-links in equipment.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 65: 1985, *Safety requirements for mains operated electronic and related apparatus for household and similar general use*

IEC 68-2-3: 1969, *Environmental testing – Part 2: Tests – Test Ca: Damp heat, steady state*

IEC 68-2-20: 1979, *Environmental testing – Part 2: Tests – Test T: Soldering*

IEC 68-2-21: 1983, *Environmental testing – Part 2: Tests – Test U: Robustness of terminations and integral mounting devices*

IEC 112: 1979, *Method for determining the comparative and the proof-tracking indices of solid insulating materials under moist conditions*

IEC 260: 1968, *Test enclosures of non-injection type for constant relative humidity*

3 Definitions

For the purposes of this standard, the following definitions apply:

3.1 **thermal-link (TL)**: A non-resettable device which will open a circuit once only when exposed for a sufficient length of time to a temperature in excess of that for which it has been designed.

3.2 **rated functioning temperature** (T_f): The temperature of the thermal-link which causes it to change its state of conductivity when measured under specified conditions.

NOTE - This temperature is pre-determined by the manufacturer.

3.3 **holding temperature** (T_c): The maximum temperature of the thermal-link at which it will not change its state of conductivity during a specified time under specified conditions.

NOTE - This temperature is stated by the manufacturer.

3.4 **maximum temperature limit** (T_m): The temperature of the thermal-link, stated by the manufacturer, up to which the mechanical and electrical properties of the thermal-link having changed its state of conductivity, will not be impaired for a given time.

3.5 **rated current** (I_r): The maximum current that the thermal-link is able to carry for a specified time at T_c without alteration of its functioning temperature.

3.6 **interrupting current** (I_b): The value of the current that the thermal-link is capable of interrupting safely at rated voltage and under specified circuit conditions.

3.7 **transient overload current** (I_p): A direct-current pulse train which the thermal-link is able to withstand without impairing its characteristics.

3.8 **rated voltage** (U_r): The voltage used to classify a thermal-link.

3.9 **creepage distance**: The shortest distance along the surface of insulating material between two conductive parts.

NOTE - An accessible surface of insulating material is considered to be a conductive part. For test purposes such surfaces are covered by metal foil.

3.10 **clearance**: The shortest distance in air between two conductive parts.

NOTE - An accessible surface of insulating material is considered to be a conductive part. For test purposes such surfaces are covered by a metal foil.

3.11 **heat capacity**: The quantity of heat required to increase the temperature of a system or a substance by 1 K. It is usually expressed in joules per kelvin.

3.12 **type test (of a product)**: A test of one or more devices made to a certain design to show that the design meets certain specifications.

3.13 **homogeneous series (of thermal-links)**: A series of thermal-links, deviating from each other only in such characteristics that, for a given test, the testing of one or a reduced number of particular thermal-links of that series may be taken as representative for all the thermal-links of the series.

3.14 **portable equipment**: Equipment which is moved while in operation or which can easily be moved from one place to another while connected to the supply.

4 General requirements

Adequate protection of the equipment against excessive temperatures not only depends upon the properties of the thermal-link but also to a large extent upon the mounting of the thermal-link in the equipment. Therefore in addition to good engineering practice, the requirements of the application guide in annex A shall be considered.

NOTE - In order not to impair the safety level of the equipment after a thermal-link has functioned, it is essential to replace the thermal-link as a whole with an identical component thus restoring electrical and thermal characteristics to the original level.

4.1 Thermal-links shall have adequate electrical and mechanical strength, and be so constructed as to withstand all conditions of handling likely to be encountered during mounting and normal use, when used within the limits of this standard.

NOTES

1 Attention is drawn to the fact that the surroundings of the thermal-link in the application may differ from the surroundings prescribed in the tests of this standard

2 Thermal-links should not be used outside the range of currents specified by the manufacturer. This is particularly important for thermal-links which, for short-circuit protection, depend upon fuse-links in the supply circuit

4.2 Thermal-links shall perform safely and reliably, and be capable of protecting the equipment during its normal life.

4.3 When a thermal-link changes its state of conductivity, no arc or flame shall be maintained, nor material expelled that might impair the surrounding area or otherwise create a hazardous situation.

NOTE - For thermal-links using melting strips or wires, care should be taken to prevent molten material from short-circuiting or bridging creepage distances and clearances in air, to avoid the risk of impairing the insulation system of the equipment

4.4 After it has functioned, the thermal-link shall not be damaged in such a way that its replacement is prevented, or the safety of the equipment with regard to shock hazard and electrical breakdown is impaired

NOTE - Due to possible thermal overshoot caused by parts, such as heating elements, with a large heat capacity, the thermal-link may be exposed, after it has functioned, to destructively high temperatures under fault conditions produced in the equipment

4.5 After it has operated, the thermal-link shall not be repairable.

5 General notes on tests

5 1 Unless otherwise indicated, all tests described in this standard are type tests.

NOTE - It is recommended that, where acceptance tests are required, they are chosen from the type tests in this standard

5.2 Unless otherwise specified, all tests shall be carried out under the following atmospheric conditions

Temperature: 15 °C to 35 °C;

Relative humidity: 45 % to 75 %;

Air pressure: $8,6 \times 10^4$ Pa to $1,06 \times 10^5$ Pa.

Where the above-mentioned conditions have a significant influence, they shall be kept substantially constant during the tests.

If the temperature limits given in this subclause are too wide for certain tests, these shall be repeated, in case of doubt, at a temperature of (23 ± 1) °C.

5.3 In every test report, the ambient temperature shall be stated. If the standard conditions for relative humidity or pressure are not fulfilled during tests, a note to this effect shall be added to the report.

5.4 If the result of any test is influenced to an appreciable extent by the position and method of mounting of the specimen, the most unfavourable condition shall be chosen for the relevant tests and recorded.

NOTE - Indications, if any, from the manufacturer's documentation should be observed.

5.5 If a thermal-link has been specifically designed for use in a special type of equipment, the tests shall be performed in that equipment or in the relevant part of it, also under fault conditions.

5.6 Measurements of voltages and currents are carried out with instruments which do not appreciably affect the values to be measured. For a.c., the test voltage is of substantially sine wave-form with a frequency between 45 Hz and 62 Hz.

5.7 In case of testing a homogeneous series of thermal-links, all the tests shall be applied to thermal-links with the lowest and highest T_f. Thermal-links with intermediate rated functioning temperatures need only be subjected to tests according to 11.1, 11.2, 11.3 and 11.4.

5.8 The total number of specimens required is 60. The number of specimens for each test shall be in accordance with table 1.

The specimens are subdivided into groups of three. The groups are numbered from 1 up to and including 15. In general, tests are to be performed in the indicated order, but if so required, tests may be repeated; for example, the dielectric strength test Out of a total of 60 specimens, 15 are kept as spares in case some of the tests have to be repeated.

5.9 No failures are permitted in the tests carried out in accordance with clauses 10 and 11.

5.10 If, in any of the tests carried out in accordance with the other clauses, one failure is reported, that test shall be repeated on twice the number of specimens and no further failures are allowed.

6 Classification

6.1 With regard to ambient conditions:

6.1.1 Thermal-links intended for use in normal atmosphere

6.1.2 Thermal-links intended for use in normal atmosphere combined with a high relative humidity

6.1.3 Thermal-links intended for use in tropical climates

Table 1 – Testing schedule

Clause and subclause	Test	Specimen groups
7	Marking	1, 2, 5, 6
9	Mechanical requirements	
9.1*	Transmission of contact pressure	1, 2, 3
9.2*	Locking of current-carrying parts	1, 2, 3
9.3*	Tensile and pushing forces	1, 2, 3
9.4*	Hole in solder lugs	4
9.5*	Tensile and bending forces	4, 5, 6
9.6*	Bending test	4, 5, 6
12*	Soldering test	4, 5, 6
13*	Resistance to rusting	6
10	Electrical requirements	
10.1*	Creepage distances and clearances	7, 8, 9
10.2*	Humidity test	1, 2, 3, 7, 8, 9
10.3*	Dielectric strength	1, 2, 3, 7, 8, 9
10.4*	Insulation resistance	1, 2, 3, 7, 8, 9
10.5*	Resistance to tracking	4, 5
10.6*	Interrupting current	7, 8, 9
10.7*	Transient overload current	1, 2, 10
11	Temperature tests	
11.1	Check on T_c, 7 days	10 to 15 inclusive
11.2	Check on T_f	1, 2
11.3	Check on T_m followed by voltage test	3, 4
11.4	Ageing	
	– step 1 (optional) 21 days	5, 6, 10 to 15 incl.
	– step 2 (mandatory) 21 days	5, 6, 10 to 15 incl.
	– step 3 (mandatory) 14 days	5, 6, 10 to 15 incl.
	– step 4 (mandatory) 7 days	5, 6, 10 to 15 incl.
	– step 5 (mandatory) 7 days	5, 6, 10 to 15 incl.
	– step 6 (mandatory) 24 hours	5, 6, 10 to 15 incl.
10.3*	Dielectric strength	10 to 12 incl.
10.4*	Insulation resistance	13 to 15 incl.

NOTE - In case of an homogeneous series, tests marked with an asterisk may be omitted for intermediate ratings.

6.2 With regard to circuit conditions:

6.2.1 Thermal-links intended for use in inductive circuits

6.2.2 Thermal-links intended for use in resistive circuits

6.3 With regard to resistance to tracking;

6.3.1 Comparative tracking index from 120 to 174

6.3.2 Comparative tracking index from 175 to 249

6.3.3 Comparative tracking index exceeding 250.

NOTE - These classes are based on test methods for surface tracking laid down in IEC 112.

7 Marking

7.1 Where size permits, each thermal-link shall be marked with:

a) rated functioning temperature T_f in degrees Celsius, with T_f followed by the number of degrees Celsius;

b) type or catalogue reference;

c) manufacturer's name or trade mark.

NOTE - For safety reasons, further marking should be omitted in order to ensure replacement with an identical thermal-link.

7.2 Marking shall be indelible and legible.

Compliance is checked by inspection and by trying to remove the marking by rubbing lightly for 15 s with pieces of cloth, one soaked with water and another with petroleum spirit. This test shall be repeated after the tests in 10.2 and 11.4.

7.3 The marking in accordance with 7.1 shall be printed on the packing together with a reference to this standard.

Compliance is checked by inspection.

8 Documentation

The manufacturer shall provide in his technical documentation, catalogues or instructional leaflets the following information in addition to that required in 7.1:

a) classification in accordance with clause 6;

b) for each of the classifications:

   1) characteristic temperatures T_f, T_c, T_m,

2) characteristic currents I_r, I_b, I_p,

3) rated voltage U_r;

c) suitability for sealing in or use with impregnating fluids or cleaning solvents;

NOTE - In order to avoid possible damage to the thermal-link, the manufacturer should be consulted if sealing in or the use of cleaning solvents is considered

d) information for mounting the thermal-link in the equipment.

NOTES

1 It should be made clear in the documentation, for reasons of safety, that a thermal-link is a non-repairable item and that, in case of replacement, an equivalent thermal-link with the same catalogue number should be used, mounted in exactly the same way

2 Catalogue or reference numbers should define those parameters such as temperature, current and voltage which together classify a thermal-link

9 Mechanical requirements

Thermal-links shall have adequate mechanical strength and stability so as to withstand the stresses likely to be encountered during handling, normal use and fault conditions.

NOTE - Normal and fault conditions should be derived from the relevant equipment specification, for example IEC 65

9.1 Current-carrying parts shall be so constructed that contact pressure is not transmitted through non-metallic material other than ceramic or material to be considered as having sufficient dimensional stability over the range of temperatures to be expected, unless there is sufficient resilience in the corresponding metal parts to compensate for any shrinkage or distortion of the non-metallic material.

Compliance is checked by inspection.

9.2 Current-carrying parts shall withstand the mechanical stresses occurring in normal use. If such parts are subjected during mounting or use to pushing, pulling or torsion, they shall be locked against any movements that may impair the reliable operation of the thermal-link, for example by spring washers, toothed rings, etc.

Compliance is checked by inspection.

9.3 Terminals shall withstand the mechanical forces likely to be encountered during normal use. With the thermal-link held in a fixed position, each terminal in turn is subjected at ambient temperature to tensile forces and, if applicable, to pushing forces in accordance with the figures or formulae from table 2.

The forces shall be exerted in the direction of the axis of the terminal and applied progressively without jerks. Pushing forces, if applicable, shall be applied at a distance of 2 mm from the thermal-link.

Table 2 – Strength of terminals

Nominal cross-sectional area A of the terminal mm^2	Tensile force N	Pushing force N
Up to and including 0,05	1	0,25
Over 0,05 up to and including 1,2	20 x (A)	5 x (A)
Over 1,2	40	8

Where screws or nuts for the mounting of thermal-links are used, they shall be suitable for their purpose.

Compliance is checked by testing. After the test the thermal-link shall not show any damage in the sense of this standard.

9.4 Terminals for soldered connections shall be provided with a means such as a hole for holding the conductor independently of the solder.

Compliance is checked by inspection.

9.5 Wire terminals shall be subjected to the tensile and bending tests mentioned under Test U: Robustness of terminations in IEC 68-2-21.

For the tensile test (Ua_1), the force applied shall be 10 N.

For the bending test (Ub), the force applied shall be 5 N and the number of bends shall be 1.

After the test, the thermal-link shall not show any damage in the sense of this standard.

9.6 Tag terminals, capable of being bent with the fingers, shall be so bent through 45°, then through 90° in the opposite direction and finally back through 45° to normal. After one complete bend the thermal-link shall not show any damage in the sense of this standard.

10 Electrical requirements

Thermal-links shall comply with the relevant requirements in this clause with regard to test voltages, currents, insulation resistances, creepage distances and clearances in air.

Thermal-links shall also meet these requirements under specified conditions of humidity and ambient temperature, corresponding with the classification laid down in 6.3.

Contacts used for the current path in a thermal-link shall safely and reliably withstand the voltage stress determined by the voltage source in the circuit. Current-carrying elements or contacts together with their terminals are usually isolated from metal parts such as mounting brackets, metal enclosures and the like, by insulating material.

If mounting brackets or metal parts of the thermal-links enclosure are accessible or connected through low impedances with metal enclosures of the equipment being accessible for the user from the outside, the insulation between the current-carrying elements of the thermal-link and such conductive enclosures shall be adequate under specified conditions of ambient temperature and humidity in accordance with their classification in clause 6 and corresponding with the relevant humidity test (see 10.2).

NOTES

1 The rated voltage U_r as stated by the manufacturer is used for deriving the relevant values for test voltages.

2 The voltage rating of a thermal-link should be based on the source voltage in the circuit. The voltage rating for the insulation between current-carrying parts of such devices and the enclosure may be increased by additional insulation, for example, by wrapping the thermal-link in insulating foil.

10.1 *Creepage distances and clearances*

Between current-carrying parts or contacts inside the enclosure of the thermal-link, the appropriate voltage as shown in table 4 is applied.

Table 3 – External creepage distances and clearances (absolute minimum values)

Rated voltage U_r V	Clearances in air mm	Creepage distances mm
30	0,35	0,58
80	0,48	0,80
130	0,76	1,37
250	1,4	2,3
380	2,1	3,4
660	3,7	5,75

Between current-carrying parts or contacts together with their terminals and the outside of the thermal-link enclosure including metal parts thereof, if any, the values indicated in table 3 for creepage distances and clearances in air shall be met as being absolute minimum values inclusive of manufacturing tolerances.

Compliance is checked by measuring the distances concerned and applying the relevant voltage of table 3 for 1 min between the parts or contacts concerned. Terminals shall be provided with connecting wires and the position of metal parts such as nuts shall be chosen as most unfavourable for the test.

10.2 *Humidity test*

Thermal-links shall not be adversely influenced by humidity present in the ambience for which they are intended, as declared by the manufacturer (see clause 6).

Compliance is checked by subjecting the specimens to the relevant humidity test as described below, followed immediately by the tests for dielectric strength (see 10.3) and insulation resistance (see 10.4).

The humidity test is carried out in a humidity chamber containing air with a relative humidity between 90 % and 95 %.

The temperature t of the air, at all places where the thermal-links can be located, is maintained at $30^{\,0}_{-2}$ °C.

Thermal-links to be used under tropical conditions are subjected to the conditions described in IEC 68-2-3: Test Ca: Damp heat, steady state temperature (40 ± 2) °C, relative humidity 90 % to 95 %.

Before being placed in the chamber, the specimens are brought to a temperature between t and $t + 4$ °C, and kept at that temperature for about 1 h.

The specimens are kept in the humidity chamber:

- for two days (48 h), in the case of thermal-links intended for use in normal atmospheres;
- for seven days (168 h), in the case of thermal-links intended for use in normal atmospheres combined with a high relative humidity;
- for five days (120 h) in the case of thermal-links intended for use in tropical climates.

After this test, the samples shall show no damage in the sense of this standard.

NOTE – Some methods of achieving the specified relative humidities are described in IEC 260

The air in the chamber should be stirred and the chamber so designed that mist or condensed water will not precipitate on specimens.

10.3 *Dielectric strength*

The dielectric strength of thermal-links shall be adequate both before and after having operated, and also after having been subjected to the relevant humidity test (see 10.2).

Compliance is checked by applying the following voltage test immediately after the humidity test of 10.2, and also after the temperature tests of clause 11.

Test voltages shall comply with the values indicated in table 4.

The insulation is subjected to a test voltage with a substantially sine-wave form having a frequency between 45 Hz and 62 Hz.

Initially not more than half the prescribed voltage is applied, then it is raised with a rate of rise of approximately 500 V/s to the full value.

Immediately after the humidity test, the enclosure shall be wrapped in metal foil and the test voltage shall be applied for 1 min across the disconnection, and between the current path and the metal foil.

The specimens are deemed to comply with the requirements if no flashover or breakdown occurs during the dielectric strength test. Glow discharges which do not cause a drop in the test voltages are neglected.

NOTE - A power transformer with an output of not less than 100 VA is recommended for this test.

Table 4 – Test voltages for dielectric strength

Between:	U_r up to and including 660 V
Current path and enclosure	$2\ U_r + 1\ 000$
Disconnection (contact parts)	$2\ U_r$

10.4 *Insulation resistance*

The insulation resistance of thermal-links shall be adequate both before and after having changed their state of conductivity, and also after having been subjected to the relevant humidity test.

Compliance is checked by measuring the insulation resistance after the humidity test, before and after having operated in the temperature test of clause 11. The insulation resistance shall be measured with a d.c. voltage of 2 U_r between the current path and the enclosure, wrapped in metal foil, if applicable, and between the terminals.

NOTE - A d.c. test voltage is preferred in order to eliminate possible deviations due to capacitive currents.

The specimens are deemed to comply with the requirements if the insulation resistance measured between the current path and the enclosures is not less than 2 MΩ, and across the disconnection not less than 0,2 MΩ.

10.5 *Resistance to tracking*

If insulating material, used for the support of current-carrying parts, contacts and terminals, is exposed during normal use to deposition of moisture or dust, this insulating material shall be resistant to tracking.

For material other than ceramic, compliance is checked by performing a tracking test in accordance with IEC 112 on specimens or flat test pieces of equivalent insulating material. Depending upon the classification of the thermal-link specimens under investigation, with regard to the ambient conditions declared by the manufacturer, one of the following comparative tracking index (CTI) values shall be met:

- in the case of thermal-links intended for use in normal atmospheres,

$$\mathrm{CTI} > 120$$

- in the case of thermal-links intended for use in normal atmospheres having a high relative humidity,

$$\mathrm{CTI} > 175$$

- in the case of thermal-links intended for use in tropical climates,

$$\mathrm{CTI} > 250$$

10.6 *Interrupting current*

Thermal-links shall safely interrupt the circuit under the applicable load conditions as specified in 6.2.

Compliance is checked by the following tests:

10.6.1 The interrupting current with thermal-links for intended use in inductive circuits is tested by thermal action of the specimen at a temperature rise of the thermal-link of (2 ± 1) K/min, with a test voltage of 1,1 U_r and with the interrupting current stated by the manufacturer but not less than 1,5 I_r in a circuit having a power factor of 0,6 ± 0,05.

10.6.2 The interrupting current with thermal-links for intended use in resistive circuits is tested by thermal action of the specimen at a temperature rise of the thermal-link of (2 ± 1) K/min, with a test voltage of 1,1 U_r and with the interrupting current stated by the manufacturer but not less than 1,5 I_r in a circuit having a power factor of not less than 0,9.

During and after these tests, no arc or flame shall be maintained, nor material expelled that might impair the surrounding area or otherwise create a hazardous situation.

The provisions of 5.5 may apply.

After these tests, the insulation resistance shall comply with the requirements of 10.4.

10.7 *Transient overload current*

Thermal-links shall safely withstand repeated current surges, considered as being normal in most applications.

Compliance is checked by the following test, performed under normal conditions as specified in 5.2.

D.C. current pulses, with an amplitude of 15 I_r and a duration of 3 ms with 10 s intervals, are applied for 100 successive cycles through the current path.

After the test, there shall be no interruption of the current path nor other damage in the sense of this standard.

11 Temperature tests

The characteristic temperatures of thermal-links shall comply with the values and tolerances as declared by the manufacturer and with the requirements of this clause.

It shall be especially ensured that the functioning temperature T_f is not influenced to any appreciable extent by thermal ageing.

Compliance is checked by subjecting specimens to one or more tests mentioned below, in the order given in table 1.

Operation of thermal-links shall be signalled by suitable means, for example, light emitting diodes with series resistors limiting the signal current to about 10 mA.

In order to ensure the required accuracy of temperature settings, indicated test temperatures shall be measured with an accuracy of ±1 °C.

Care shall furthermore be taken that temperature differences in that part of the oven where the specimens are tested, do not exceed 1 °C at any point.

NOTE - This may be obtained for example by placing the specimens within a thick-walled aluminium box mounted in such a way that it is not in direct contact with the internal walls of the oven.

11.1 *Holding temperature* (T_c)

The specimens shall be stored in a test oven and loaded with rated current at any convenient voltage not exceeding the rated voltage. The temperature of specimens shall be maintained at holding temperature $T_c{}^{0}_{-6}$ °C for a period of 7 days (168 h).

At the conclusion of the test, the specimens shall not have changed their state of conductivity and shall have remained unaffected in the sense of this standard.

11.2 *Rated functioning temperature* (T_f)

Thermal-links shall be exposed in the test oven to T_f -20 K for at least 2 h Then the temperature shall be increased steadily with a rate of rise between 0,5 K/min to 1 K/min until all specimens have functioned The individual functioning temperatures shall be recorded and they shall be not less than T_f -10 K and not greater than T_f

11.3 *Maximum temperature limit* (T_m)

The specimens shall be subjected to $T_{m\ -5}^{\ \ 0}$ °C for a period of 10 min and during a further period of 2 min a test voltage of 2 U_r shall be applied between current-carrying parts and insulated exposed metal parts

No flashover, breakdown or refunctioning shall occur At the conclusion of this test all specimens shall have functioned

NOTE - If it is deemed necessary to overcome possible effects of thermal inertia of the specimens and any necessary connections, and also to facilitate the introduction of the specimens into a suitable heating chamber, it is recommended where possible that the specimens be inserted into a sand box maintained at T_m

11 4 *Ageing*

In order to verify whether ageing at high temperature has a deleterious effect, thermal-links shall be subjected to the following series of test steps

- temperature shall be maintained constant within ±1 K,
- specimens remaining intact at the conclusion of each step shall be submitted to the next step Conformity shall be considered satisfactory if all specimens have functioned after the first two steps

Step 1 – If requested by the manufacturer the specimens are subjected to a temperature chosen between T_f - 15 K and T_c for a period of three weeks At the conclusion of the test at least 50 % of the specimens shall not have functioned

The following tests are mandatory

Step 2 – T_f – 15 K for three weeks At the conclusion of the test at least 50 % of the specimens shall not have functioned unless the specimens have already been submitted to Step 1, in which case all specimens may have functioned

Step 3 – T_f – 10 K for two weeks

Step 4 – T_f – 5 K for one week

Step 5 – T_f – 3 K for one week

Step 6 – T_f + 3 K for 24 h.

The specimens shall then cool in the test chamber to less than T_f – 35 K

All shall have functioned

12 Soldering test

Soldering terminals shall be subjected to the soldering test specified in IEC 68-2-20.

For components intended to be used in printed circuits the solder bath method shall be used and the soldering iron method, bit size A, for all other types.

The solder shall adhere properly within the time specified in IEC 68-2-20.

After the test, the specimens shall still comply with the requirements of this standard.

13 Resistance to rusting

Thermal-links provided with one or more ferrous parts shall not be adversely affected by possible rusting of such parts.

Compliance is checked by subjecting three specimens during 14 days to the humidity test described for tropical conditions in 10.2.

After the test, the specimens are dried in air at a suitable temperature and the ferrous parts shall show no sign of rusting that might impair the performance of the thermal-links in the sense of this standard.

Annex A
(normative)

Application guide

A.1 Instructions for mounting given by the manufacturer of the thermal-link shall be followed, especially in the case where thermal-links are provided with a coating or used in impregnated windings

A.2 Thermal-links shall be chosen such that all prevailing electrical requirements with regard to insulation resistance, dielectric strength, creepage distances in air and clearances are met under normal and fault conditions, specified in the relevant equipment standard For example, for mains-operated electronic and related apparatus for household and similar general use, see IEC 65

A.3 Thermal-links shall be chosen such that, in the mounted position, their electrical and thermal insulation shall not be degraded by thermal overshoot effects produced under fault conditions in the equipment

A.4 If thermal-links in the form of melting wires or strips are applied barriers shall be provided so that sagging of such elements or possible droplets of molten metal cannot produce harmful effects

If such melting wires are clamped or pressed under screws, rivets or terminals, it shall be verified that mechanical creepage phenomena do not result in unreliable electrical contacts

NOTE For hand held or portable equipment this provision applies irrespective of their attitude

A.5 Electrical connections shall function reliably over the range of temperatures to which they may be exposed in the equipment

Connectors and terminals shall not loosen easily due to vibration, shock and the like

A.6 Soldered connections if any, shall not rely solely on the solder alloy for their mechanical rigidity but include mechanical anchoring, for example a wire bent through a hole in a terminal

A.7 The mechanical strength and rigidity of the hardware used for mounting the thermal-link shall be adequate Brackets, clamps or screws used for mounting the thermal-link shall withstand pushing and pulling forces, torques, vibrations and cyclic temperature changes expected during normal operating conditions of the equipment

A.8 The mounted thermal-link shall be adequately protected from harmful effects produced by possible spillage of liquids from the equipment, for example by covers

Annex B
(normative)

Alternate ageing for TL with T_c greater than 225 °C

Thermal-links for use to protect electric irons where the normal holding temperatures are 225 °C or greater and which, in the event of failure, rise rapidly to functioning temperatures of 300 °C or higher would not be required to follow the usual ageing test described in 11.4.

Additionally the tolerance of T_f *in 11.2 is allowed to be –20 K instead of –10 K.*

All other requirements of this standard, however, shall be met in order to conform with this standard.

It is also necessary to carry out further tests to ensure that the thermal links operate correctly and safely after the iron has been subjected to its specific life test.

IEC
691

1993

Amendment 1

Thermal-links – Requirements and application guide

Page 1

1 Scope and object

Replace the existing subclause 1.4 by the following:

1.4 This standard is applicable to thermal-links with a rated voltage not exceeding 690 V a.c. or d.c and a rated current not exceeding 63 A

Replace the existing subclause 1 6 by the following

1.6 This standard is not applicable to thermal-links to be used in circuits on a c with a frequency lower than 45 Hz or higher than 62 Hz

Page 2

2 Normative references

Insert, in the existing list, the titles of the following standards.

IEC 335-2-3: 1993, *Safety of household and similar electrical appliances – Part 2 Particular requirements for electric irons*

IEC 664-1: 1992, *Insulation coordination for equipment within low-voltage systems – Part 1 Principles, requirements and tests*

Page 2

3 Definitions

Replace the existing note of definition 3.3 by the following:

NOTE – This temperature, time and conditions are declared by the manufacturer.

Page 4

5 General notes on tests

Replace, on page 17, the text of subclause 5.8 by the following:

5.8 The total number of specimens required is 45. Out of a total of 45 specimens, 15 are kept as spares in case some of the tests have to be repeated. Out of a total of 45 specimens, 30 are divided into groups assigned an alphabetical letter from A to J. Each group consists of three specimens. In general, tests are to be performed in the order indicated in table 1 but, if so required, tests may be repeated, for example the test on marking (see 7.2).

Page 6

Table 1 - Testing schedule

Replace the existing table 1 by the following:

Table 1 - Testing schedule

Clause and subclause	Test		Specimen groups
7	Marking		A, B, E, F
9	Mechanical requirements		
9 1*	Transmission of contact pressure		A B, C
9 2*	Locking of current-carrying parts		A, B, C
9 3*	Tensile and pushing forces		A, B, C
9 4*	Hole in solder lugs		D
9,5*	Tensile and bending forces		D, E, F
9 6*	Bending test		D, E, F
12*	Soldering test		D, E, F
13*	Resistance to rusting		F
10	Electrical requirements		
10 1*	Creepage distances and clearances		G H, I
10 2*	Humidity test		A, B C, G, H, I
10 3*	Dielectric strength		A, B, C, G H, I
10 4*	Insulation resistance		A, B, C, G H I
10 5*	Resistance to tracking		D, E
10 6*	Interrupting current		G, H, I
10 7*	Transient overload current		A, B, J
11	Temperature tests		
11 2	Check on T_f		A, B
11 3	Check on T_m followed by voltage test		C, D
11 4	Ageing		
	- step 1 (optional)	21 days	E, F, J
	- step 2 (mandatory)	21 days	E, F, J
	- step 3 (mandatory)	14 days	E, F, J
	- step 4 (mandatory)	7 days	E, F, J
	- step 5 (mandatory)	7 days	E, F, J
	- step 6 (mandatory)	24 hours	E, F, J
10 3*	Dielectric strength		J
10 4*	Insulation resistance		J

NOTE - In case of a homogeneous series, tests marked with an asterisk may be omitted for intermediate ratings

Page 7

7 Marking

Replace the existing subclause 7 1 by the following

7 1 Each thermal-link shall be marked with

a) type or catalogue reference,

b) manufacturer's name or trade mark

c) rated functioning temperature T_f, with or without the symbol T_f followed by the number of degrees Celsius (marked with °C or C)

Where size permits, additional markings such as rated voltage followed by V, rated current followed by A, date code and other optional markings as needed may be placed on the thermal-link

Page 9

10 Electrical requirements

Replace, at the end of the last paragraph on page 25, "6 3" *by* "6 1"

Replace, in the last line of the second paragraph on page 27, "clause 6" *by* "6 1"

Page 10

10 1 *Creepage distances and clearances*

Replace this subclause by the following

The values in table 3 apply for creepage distances and clearances between current-carrying parts (of contacts together with their terminals) and the outside of the thermal-link enclosure including metal parts thereof, if insulated from live parts The values indicated are absolute minimum values and inclusive of manufacturing tolerances

These distances do not apply between the open contacts of a thermal-link

Compliance is checked by measuring the distances concerned

Table 3 - Creepage distances and clearances
(absolute minimum values)

Rated voltage U_r V	Clearance mm	Creepage distance mm
0 - 125	0,5	1,5
126 - 250	1,5	2,5
251 - 400	3,0	4,0
401 - 690	4,0	6,9

NOTES

1 The clearance/creepage distances are specified according to IEC 664-1

2 The values specified are for typical applications of thermal-links assuming
a) continuous voltage stress,
b) altitude 2 000 m,
c) basic insulation,
d) inhomogeneous field,
e) overvoltage category II,
f) pollution degree 2,
g) material group IIIa

3 If conditions are different from those specified in note 2, adjustments in clearances/creepages may be necessary as per IEC 664-1

Page 11

10 2 *Humidity test*

Replace, at the end of the first paragraph, "(see clause 6)" *by* "(see 6 1)"

10 3 *Dielectric strength*

Change, on page 31, the heading of the second column of table 4 to read

U_r up to and including 690 V

Page 13

10.5 *Resistance to tracking*

Replace the first paragraph by the following:

If insulating material used for the support of current-carrying parts, contacts and terminals is exposed during normal use to deposition of moisture or dust, it shall be resistant to tracking

Page 14

11.1 *Holding temperature (T_c)*

Replace the existing text of this subclause by the following:

If requested by the manufacturer, the specimen(s) is (are) subjected to the specified time and other conditions as declared by the manufacturer.

Page 15

11.2 *Rated functioning temperature (T_f)*

Replace the first sentence of this subclause by the following·

Thermal-links shall be exposed, in the test oven or oil bath, to $T_f - 20$ K for at least 2 h.

11.3 *Maximum temperature limit (T_m)*

Replace the first paragraph of this subclause by the following:

The specimens shall be subjected to $T_{m}{}^{\ 0}_{-5}$ °C for a period of 10 min, and, during a further period of 2 min, a test voltage of 2 U_r shall be applied between current-carrying parts and insulated exposed metal parts, if any, or between terminals of an opened thermal-link.

Page 17

Annex A - Application guide

Replace the second paragraph of clause A.5 by the following:

Connectors and terminals shall not loosen easily due to vibration, shock, thermal cycling and the like.

Page 18

Annex B - Alternate ageing for TL with T_c greater than 225 °C

Change the title of this annex to read:

Alternate ageing for TL with T_c greater than 250 °C

Replace, in the first paragraph, "225 °C" *by* "250 °C".

Add the following sentence to the first paragraph:

The alternate ageing test is conducted as per IEC 335-2-3.

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This Indian Standard has been developed from Doc : No. ET 39 (3455).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Printed at Simco Printing Press, Delhi